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B R O O K H A V E N N A T I O N A L L A B O R A T O R Y

A. G. S. D E P T.

M A I N T E N A N C E M A N U A L

BTA INSTRUMENTATION CONTROLLER

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1.0 _Safety Considerations.1.1 Hazardous circuits. The BTA Instrumentation controller contains 110 vac circuits within the enclosed chassis. A warning sign is posted on the outside of the controller bucket. Only qualified knowledgeable personnel should open the controller bucket.

1.2 Fans - There are three fans with exposed blades inside the controller bucket.

1.3 Remote equipment - The BTA Instrument controller has internal circuits and exposed fan blades which can be considered hazardous but it also controls remote equipment that could cause harm to personnel. The device operates instrumentation plungers which could be undergoing maintenance. These devices should be in the local mode at these times but anybody wishing to operate the controller via computer should be aware of any maintenance work in the area.

2.0 General Description

2.1 Purpose of Equipment - The BTA instrumentation controller controls and reports the status of all the beam instrumentation in the BTA line. The controller also digitizes signals from the various instruments and reports the data to programs running on the various control consoles. The controller provides the timing needed by the BTA instruments.

2.2 Functional description The BTA instrument controller supports the following BTA transfer line instrumentation.

A. Up to 6 Harp profile monitors
B. 3 Beam current transformers

Each harp has an SLD to insert or retract the device. A Harp that has been requested to insert or retract does so after the Booster Group End code so the harp body does not interfere with the beam.
NOTE: The harps require 400 ms to fully insert or retract. Therefore no beam can be present for that amount of time after EOG.

There are SLD's to set the gain for the harp electronics and Transformer gain. When a data report request is received the controller waits unit the next occurrence of User reset that was indicated in the request for data and report the data taken from the next pulse until the next occurrence of EOG. The data request CLD's contain the number of reports requested. The controller keeps track of the number of reports remaining and if two or more requests are received from the same user the number of reports remaining will always be the largest number. If the number of reports requested = FFh then the controller reports data until a request is sent requesting zero reports.
The controller decodes the following events from the Real- time line

1. BGE(Booster Group End). BGE will be used as an interrupt. If a Harp has been commanded to insert or retract it will do so at BGE. Incoming gain, cal commands and harp integrate times will not become active until BGE so that a group will not contain mixed commands or setpoints. Also any stacking of data reports during the last cycle is done at BGE.

2. User Reset - Interrupt to record what user is next so the controller can set the proper values for gains and timing just prior to a booster cycle.

3.Booster T0 - Interrupt used by the controller to set the gains and timing for the proper user.

Timing for data acquisition is as follows.
At Booster T0 the gains and Harp Integrate Start Time is setup for the user requested in preparation for the extraction phase of the booster cycle. The Harp integrator Reset/ Xfmr trigger will occur 10us prior to the Harp integrator start time. If the Calibrate command is active, the Cal trigger pulse will also occur 10us prior to Harp integrator start. Harp integrator stop time will occur 10us after Harp integrator start time. All times will be from the extraction precursor which will occur approximately 1 ms before extraction. The BTA electronics includes a Multiplexer Control unit for each Harp. The BTA harp data is acquired by reading the harp scanners after the booster extraction phase. The transformers are also read after the booster extraction phase. Harp data is only reported as valid if the harp is fully inserted or fully retracted when the data is taken. If the harp is not fully inserted or retracted at the beginning of a cycle then the data field , for that cycle, contain zeros.
Calibration of the transformers takes place during the time when the beam is normally present except the beam will be turned off by operations.
2.3 Specifications -

2.3.1 Digital signals - All digital outputs and inputs for the BTA Instrumentation controller are TTL level signals.

2.3.2 Analog input signals - All analog signals are in the range of +/- 10 V. Resolution D/A is 11 bits + sign.

2.3.3 Connectors -
Digital I/O connectors are 3 female 50 pin Scotch Delta Ribbon connectors.

Analog connectors are 2 male 50 pin Scotch Ribbon connectors.

Relway connectors are standard IEEE - 488 connectors

BTAS Instrumentation Controller Device Summary
Controller = CDC.BTA_INST
SLD's

NOTE: All SLD's with command fields or setpoints have a status field that is Illegal cmd/ Normal

LD	Data Base Name	PPM	St	RB	Function	Commands	Status
0	BMD.Bta_Inst.D0	N	N	Y	LDN0	N	RptRdy/Nor
	Spare status 3 - 8						
	User status 1 - 8						
1-7	BMD.Bta_Inst.Rack'n *	N	N	N	Rack 1-7 status	N	Nor/Local
	Nor/Aux_ps fault						
10-15	BTA.MW'n'	N	N	N	Harp cmd	In/Out	In/Out/Mid
16	BTA.MW_Gain	Y	N	N	Harp Gain	High/Med/Low	High/Med/Low
17	BTA.XF_Gain	Y	N	N	Transformer Gain	High/Low	High/Low
						X1/X10	X1/X10

|18 | BTA.XF_Cal | Y | N | N | Transformer Cal | Cal/Normal | Cal/Normal

| 19 | BTA.MW_Int_Delay | Y | Y | N | Harp Integrate St | N | N

Requests for data reports and data rpts

|100-106| BTA.MW_Data | Y | N | Y | BTA Harp Data | N | N

| 107 | BTA.XF_Data | Y | N | Y | BTA Xfmr Data | N | N

Cal Data input

|120-126|BTA.MW_Cal_Data | Y | Y | N | BTA Harp Cal. Data | N | N

| 127 |BTA.XF_Cal_Data | Y | Y | N | BTA Xfmr Cal. Data | N | N

* assuming that there are 7 buckets of instrumentation electronics

2.4 Print Numbers

2.4.1 BTA Instrument controller interface card.
2.4.2 BTA Instrument controller chassis wiring.
2.4.5 LTB Instrumentation controller rear panel. DO9 - M - 612
2.4.6 PP Linac Timer Card DO9 - E - 1527
2.4.7 Booster Multibus 1 Receiver/Decoder D36 - E - 360

3.0 _Operating Instructions_

3.1 Reference Guide

BTA Instrumentation Controller

_ WARNING_

Operation of the BTA Instrumentation controller causes beam instruments to move in and out of the beam.

Resetting the controller will result in all devices returning to initialized values. All instruments will be withdrawn and all timer values will return to default values. All requests for data reports will be canceled.

Electrical feed - 110vac

Station -

Combox -

Service Group - Accelerator Controls Section

Turn off procedure - turn off circuit breaker on rear panel.

Turn on procedure - check that all timing, ribbon cables and IEEE - 488 cables are connected and turn circuit breaker on rear panel on. Make sure equipment controlled by the controller is ready.

Reset Procedure - The BTA Instrumentation controller can be reset by pushing the left most reset button on the rear panel. The right button will only reset the control section. See warning about resetting above.

3.2 Preturn on procedure - check that the timing cables are connected. Check that all digital I/O and analog input ribbon cables are connected. Check that the IEEE -488 cable to the station is connected.

3.3 Local turn on/ off procedure - The BTA Instrumentation controller is turned on and off by the circuit breaker on the rear panel.

4.0 Performance tests

4.1 Equipment required

4.1.1 Apollo node running spread sheet and configure

4.1.2 Gaussline and Real-time lines.

4.1.3 Digital voltmeter

4.1.4 Calibrator Datel DVC 8500A

4.1.5 Scope

4.1.6 BTA instrument controller I/O documentation (see below)

April 10, 1991

DIGITAL I/O ASSIGNMENTS AND TIMING SIGNAL I/O FOR BTA INSTRUMENTATION CONTROLLER

Digital I/O 519 - logic board interface

FUNCTION	519 Pin #	Int. Card	Port	Bit
Harp 1 Command	J1 - 48	J1 - 47	1	0
Port 1 = output				
Harp 2 Command	J1 - 46	J1 - 45	1	1
Harp 3 Command	J1 - 44	J1 - 43	1	2
Harp 4 Command	J1 - 42	J1 - 41	1	3
Harp 5 Command	J1 - 40	J1 - 39	1	4
Harp 6 Command	J1 - 38	J1 - 37	1	5
Harp Gain bit 1	J1 - 36	J1 - 35	1	6
Harp Gain bit 2	J1 - 34	J1 - 33	1	7
EOC Status	J1 - 16	J1 - 15	2	0
Port 2 = input				
Spare	J1 - 14	J1 - 13	2	1
Spare	J1 - 12	J1 - 11	2	2
Spare	J1 - 10	J1 - 9	2	3
Spare	J1 - 8	J1 - 7	2	4
Spare	J1 - 6	J1 - 5	2	5
Spare	J1 - 4	J1 - 3	2	6
Spare	J1 - 2	J1 - 1	2	7
Start Scan	J1 - 24	J1 - 23	3	0
Port 3 = output				
Calibrate	J1 - 22	J1 - 21	3	1

Xfr Read	J1 - 20	J1 - 19	3	2
Data Rdy	J1 - 18	J1 - 17	3	3
Xfmr Gain bit 1	J1 - 26	J1 - 25	3	4
Xfmr Gain bit 2	J1 - 28	J1 - 27	3	5
Spare	J1 - 30	J1 - 29	3	6
Spare	J1 - 32	J1 - 31	3	7

NOTE: 519 J1 odd pins are gnd and interface card J1 even pins are gnd.

Digital in - 1 519 board - rear panel DIN - 1 interface
DIN - 1 is a 50 Pin female 3M Delta Ribbon connector #3565-1000

FUNCTION	519 Pin #	IC Pin #	Port	Bit
Harp 1 Out	J2 - 48	DIN-1 24	4	0
Harp 1 In	J2 - 46	DIN-1 23	4	1
Harp 2 Out	J2 - 44	DIN-1 22	4	2
Harp 2 In	J2 - 42	DIN-1 21	4	3
Harp 3 Out	J2 - 40	DIN-1 20	4	4
Harp 3 In	J2 - 38	DIN-1 19	4	5
Harp 4 Out	J2 - 36	DIN-1 18	4	6
Harp 4 In	J2 - 34	DIN-1 17	4	7
Harp 5 Out	J2 - 16	DIN-1 8	5	0
Harp 5 In	J2 - 14	DIN-1 7	5	1
Harp 6 Out	J2 - 12	DIN-1 6	5	2
Harp 6 In	J2 - 10	DIN-1 5	5	3
Spare	J2 - 8	DIN-1 4	5	4
Spare	J2 - 6	DIN-1 3	5	5
Spare	J2 - 4	DIN-1 2	5	6
Spare	J2 - 2	DIN-1 1	5	7
Spare	J2 - 24	DIN-1 12	6	0
Spare	J2 - 22	DIN-1 11	6	1
Spare	J2 - 20	DIN-1 10	6	2

Spare	J2 - 18	DIN-1 9	6	3
Spare	J2 - 26	DIN-1 13	6	4
Spare	J2 - 28	DIN-1 14	6	5
Spare	J2 - 30	DIN-1 15	6	6
Spare	J2 - 32	DIN-1 16	6	7

NOTE: 519 J2 odd pins are gnd. DO1 pins 26 - 50 are gnd.

Digital In - 2 519 board - rear panel DIN - 2 interface
DIN - 2 is a 50 Pin 3M Delta ribbon connector #3565-1000

FUNCTION	519 Pin #	IC Pin #	Port	Bit
Rack 1 PS Status	J3 - 48	DIN-2 24	7	0
Rack 1 Local/Remote	J3 - 46	DIN-2 23	7	1
Rack 2 PS Status	J3 - 44	DIN-2 22	7	2
Rack 2 Local/Remote	J3 - 42	DIN-2 21	7	3
Rack 3 PS Status	J3 - 40	DIN-2 20	7	4
Rack 3 Local/Remote	J3 - 38	DIN-2 19	7	5
Rack 4 PS Status	J3 - 36	DIN-2 18	7	6
Rack 4 Local/Remote	J3 - 34	DIN-2 17	7	7
Rack 5 PS Status	J3 - 16	DIN-2 8	8	0
Rack 5 Local/Remote	J3 - 14	DIN-2 7	8	1
Rack 6 PS Status	J3 - 12	DIN-2 6	8	2
Rack 6 Local/Remote	J3 - 10	DIN-2 5	8	3
Rack 7 PS Status	J3 - 8	DIN-2 4	8	4
Rack 7 Local/Remote	J3 - 6	DIN-2 3	8	5
Spare	J3 - 4	DIN-2 2	8	6
Spare	J3 - 2	DIN-2 1	8	7
Spare	J3 - 24	DIN-2 12	9	0
Spare	J3 - 22	DIN-2 11	9	1
Spare	J3 - 20	DIN-2 10	9	2
Spare	J3 - 18	DIN-2 9	9	3

Spare	J3 - 26	DIN-2 13	9	4
Spare	J3 - 28	DIN-2 14	9	5
Spare	J3 - 30	DIN-2 15	9	6
Spare	J3 - 32	DIN-2 16	9	7

NOTE: 519 J3 odd pins are gnd. DIN pins 26 - 50 are gnd.

Logic board - conditioned digital outputs - rear panel DO - 1
DO - 1 is a 50 Pin 3M Delta ribbon connector #3565-1000

FUNCTION	Int. Card	I.C. PIN #
Harp Int Start	J2 - 1	DO-1 1
Harp Int. Stop	J2 - 3	DO-1 2
Int. Reset/Xfmr trigger	J2 - 5	DO-1 3
Start Scan	J2 - 7	DO-1 4
Advance	J2 - 9	DO-1 5
Cal Trigger	J2 - 11	DO-1 6
Harp 1 command	J2 - 13	DO-1 7
Harp 2 command	J2 - 15	DO-1 8
Harp 3 command	J2 - 17	DO-1 9
Harp 4 command	J2 - 19	DO-1 10
Harp 5 command	J2 - 21	DO-1 11
Harp 6 command	J2 - 23	DO-1 12
Harp Gain bit 1	J2 - 25	DO-1 13
Harp Gain bit 2	J2 - 27	DO-1 14
Xfmr Gain bit 1	J2 - 29	DO-1 15
Xfmr Gain bit 2	J2 - 31	DO-1 16
Spare	J2 - 33	DO-1 17
Spare	J2 - 35	DO-1 18
Spare	J2 - 37	DO-1 19
Spare	J2 - 39	DO-1 20
Spare	J2 - 41	DO-1 21

Spare	J2 - 43	DO-1 22
Spare	J2 - 45	DO-1 23
Spare	J2 - 47	DO-1 24
Spare	J2 - 49	DO-1 25

Note - unused pins on J2 and DO-2 will be ground

Timing card - Logic card interface

FUNCTION	Int Card	Timing Card	
Harp Int Hold	P2 - 1	J1 - 48	(A2)
/Harp int Hold	P2 - 2	J1 - 47	
Advance	P2 - 3	J1 - 46	(A3)
/Advance	P2 - 4	J1 - 45	
Stop Scan(adv count output)	P2 - 5	J1 - 44	(A4) Counter number
/Stop Scan	P2 - 6	J1 - 43	
Harp int reset/xfmr trigger	P2 - 7	J1 - 42	(A5)
/Harp int reset/xfmr trigger	P2 - 8	J1 - 41	
Spare timer 1	P2 - 9	J1 - 40	(B2)
/Spare timer 1	P2 - 10	J1 - 39	
Spare timer 2	P2 - 11	J1 - 38	(B3)
/Spare timer 2	P2 - 12	J1 - 37	
Spare timer 3	P2 - 13	J1 - 36	(B4)
/Spare timer 3	P2 - 14	J1 - 35	
Spare timer 4	P2 - 15	J1 - 34	(B5)
/Spare timer 4	P2 - 16	J1 - 33	
Harp Int Start	P2 - 17	J1 - 24	(A1)
/Harp Int. Start	P2 - 18	J1 - 23	
A/D trig delay	P2 - 20	J1 - 22	(B1)
/A/D trig delay	P2 - 19	J1 - 21	

GND	P2 - 21	J1 - 1
GND	P2 - 22	J1 - 3
Advance En	P2 - 23	J1 - 4
GND	P2 - 24	J1 - 5
Extrac trig (timer gates)	P2 - 25	J1 - 8
GND	P2 - 26	J1 - 9
A/D Trigger Gate	P2 - 27	J1 - 2

Logic card P2 misc.

Function	From	To
A/D board trigger- delayed	P2 - 53	Analog card P2 - 21
Gnd	P2 - 54	
EOC Status	P2 - 55	Analog Card P2 - 23
Gnd	P2 - 56	
Gnd	P2 - 57	
Gnd	P2 - 58	

Logic card J3

Scope trigger Start Scan	J3 - 13	Rear Panel BNC
Scope trigger Start Scan Lo	J3 - 14	Rear Panel BNC
Reset to 18603	J3 - 15	18603 J4 - 9
Reset to Cont. Sec. Rst Sw	J3 - 16	Cont sec. reset sw.
Comm Sec init	J3 - 17	Comm Sec. P1 - 14
Ext. trig BNC	J3 - 19	Rear panel BNC
Ext. trig BNC lo	J3 - 18	Rear panel BNC
Extrac. Trig	J3 - 1	Timing decoder J2-17
/Extrac. trig	J3 - 2	Timing decoder J2-18

Bt0 delayed	J3 - 3	Timing decoder J2-19
/Bt0 delayed	J3 - 4	Timing decoder J2-20
Clock Sync - extract. trig	J3 - 8	Timing decoder J2-2
Gnd	J3 - 7	Timing decoder J2-1

Timing board inputs

Signal	From	Timing Bd
1 MHZ CLK	Timing decoder J3 - 2	P2 - 4
GND	Timing decoder J3 - 1	P2 - 2

MISC.

Signal	From Comm section multibus	To Control sect. Multibus	
BGE	P1 - 38	P1 - 38	MB INT 5
Data Rdy	P1 - 42	P1 - 42	MB INT 1

EVENT LINE INPUTS

Signal	From	Timing Decoder
Gauss Event line +	Rear Panel Gauss Twinex	P2 - 48
Gauss Event line -	Rear Panel Gauss Twinex	P2 - 47
RealTime line +	Rear Panel Realtime Twinex	P2 - 56
RealTime line -	Rear Panel Realtime Twinex	P2 - 55

Analog signals

Analog input connectors (AI1,2)are 50 pinmale3M Delta ribbon connectors # 3564 - 1000

Channel	FUNCTION	RTI - 711	Analog in 1
Ch 0 Hi	Scanner 1 - Harp 1 Hi	J2 - 4	AI1 - 2
Ch 0 Lo	Scanner 1 - Harp 1 Lo	J2 - 6	AI1 - 3
Ch 1 Hi	Scanner 2 - Harp 2 Hi	J2 - 8	AI1 - 4
Ch 1 Lo	Scanner 2 - Harp 2 Lo	J2 - 10	AI1 - 5
Ch 2 Hi	Scanner 3 - Harp 3 Hi	J2 - 12	AI1 - 6
Ch 2 Lo	Scanner 3 - Harp 3 Lo	J2 - 14	AI1 - 7
Ch 3 Hi	Scanner 4 - Harp 4 Hi	J2 - 16	AI1 - 8
Ch 3 Lo	Scanner 4 - Harp 4 Lo	J2 - 18	AI1 - 9
Ch 4 Hi	Scanner 5 - Harp 5 Hi	J2 - 20	AI1 - 10
Ch 4 Lo	Scanner 5 - Harp 5 Lo	J2 - 22	AI1 - 11
Ch 5 Hi	Scanner 6 - Harp 6 Hi	J2 - 24	AI1 - 12
Ch 5 Lo	Scanner 6 - Harp 6 Lo	J2 - 26	AI1 - 13
Ch 6 Hi	Spare Hi	J2 - 28	AI1 - 14
Ch 6 Lo	Spare Lo	J2 - 30	AI1 - 15
Ch 7 Hi	Spare Hi	J2 - 32	AI1 - 16
Ch 7 Lo	Spare Lo	J2 - 34	AI1 - 17

			Analog in 2
Ch 8 Hi	BTA Xfmr 1 Hi	J3 - 4	AI2 - 2
Ch 8 Lo	BTA Xfmr 1 Lo	J3 - 6	AI2 - 3
Ch 9 Hi	BTA Xfmr 2 Hi	J3 - 8	AI2 - 4
Ch 9 Lo	BTA Xfmr 2 Lo	J3 - 10	AI2 - 5
Ch 10 Hi	BTA Xfmr 3 Hi	J3 - 12	AI2 - 6

Ch 10 Lo	BTA Xfmr 3 Lo	J3 - 14	AI2 - 7

4.2 Operational Verification Procedures

4.2.1 Harp Actuators

4.2.1.1 With actual instruments commanding an instrument to insert should result in the instrument report indicating " In" on spread sheet. Commanding an instrument to retract should result in the instrument report indicating "Out" on spreadsheet.

4.2.1.2 With digital cables disconnected. Use a meter or scope to look at the output line associated with the actuator being tested. (see I/O doc. above).

4.2.3 The various gains are checked by issuing the appropriate command and seeing that the correct levels are present on the line associated with that function and that the correct status is indicated on the instrumentation electronics.(see I/O doc. above).

4.2.4 Timing is checked by triggering the scope on Ext. Precursor and looking at the outputs. The Harp Integrator Start should occur at the time set on spread sheet. Harp integrator Stop should occur 10 us later and Harp int. Reset/Xfmr trigger should occur 10 us prior to Harp int. Start. If Cal is active then the Cal trigger should occur at the same time as Harp int. reset/xfmr trigger. (see I/O doc above).

4.2.5 The A/D is checked by applying the input voltage source to the analog input and asking for a data report from a device using configure. The report as seen in configure should report the hex equivalent of the voltage applied.

4.2.6 The Calibration of the A/D card is checked by varying the voltage calibrator and asking for reports from a particular device as the voltage is increased or decreased for each step. See the calibration sheet below.

Calibration of BTA Instrumentation Controller

Analog Devices RTI - 711 A/D Card

Meter - Beckman Tech 310 s.n. 212144446
Calibrator - Datel DVC 8500A s.n. 09670279

Lsb for A/D is 4.9 mv

Input V +	Reading Hex	Input V -	Reading Hex
0	0	0	0
.5 v	67	- .5 v	FF9A
1.0 v	CD	- 1 v	FF34
1.5 v	133	- 1.5 v	FECD
2.0 v	19A	- 2.0 v	FE67
2.5 v	200	- 2.5 v	FE01
3.0 v	267	- 3.0 v	FD9A
3.5 v	2CD	- 3.5 v	FD33
4.0 v	334	- 4.0 v	FCCD
4.5 v	39A	- 4.5 v	FC67
5.0 v	400	- 5.0 v	FC00
5.5 v	467	- 5.5 v	FB9A
6.0 v	4CD	- 6.0 v	FB34
6.5 v	534	- 6.5 v	FACE
7.0 v	59A	- 7.0 v	FA67
7.5 v	601	- 7.5 v	FA00
8.0 v	667	- 8.0 v	F99B
8.5 v	6CD	- 8.5 v	F933
9.0 v	733	- 9.0 v	F8CD
9.5 v	79A	- 9.5 v	F867
10.0 v	7FF	-10.0 v	F800

5.0 Maintenance

5.1 Planned Maintenance Schedule

Once a year during the Summer Shutdown the fans inside the BTA instrumentation controller should be checked for proper operation.

At the same time the controller should be checked for dust accumulation.

5.2 Planned Maintenance procedures

To check proper operation of the fans turn the controller off and back on. The fans should start up immediately. If not or if the fan seems abnormally noisy, the fan should be replaced.

If the dust accumulation inside the chassis is excessive then the boards should be removed and cleaned and the inside of the chassis should be vacuumed. The multibus connectors on the backplane should be carefully checked for foreign matter between or on the connector pins.

5.3 Trouble Analysis Chart

NOTE: Any of the following problems could possibly be rectified by resetting the controller.
All of the problems described below could be the result of a bad power supply. Power supply voltages can be checked on front panel.

Symptom	Possible fault
No SLD Reports disconnected	1. Station or combox down 2. Station not loaded with controller/ Devices 3. Controller not turned on 4. IEEE - 488 cable to station 5. CM4 boardfaulty 6. Bad connection between CM4 and IEEE - 488 connector
Instruments cannot be inserted	1. Digital I/O ribbon cable disconnected 2. Interface card faulty 3. Parallel I/O 519 card faulty 4. Bad connection between cards inside controller
No data, no timing pulses	1. Digital I/O ribbon cable disconnected 2. Time lines disconnected 3. Bad timing decoder card 4. A/D card faulty 5. Interface card faulty 6. Timing card faulty 7. Bad connection between cards in controller

6.0 Special Replacement Parts

Part	Supplier	In use	Spares
SBC 88/25 CPU	Intel	1	1
SBC 186/03 CPU	Intel	1	1
MM7200D Memory	Micro Memory	1	1
SBC 519 Digital I/O	Intel	2	1

RTI 711 Analog Input	Analog Devices	1	1	

NOTE: Spare parts may be shared by other controllers. For example there may be an 88/25 board that is a spare for this controller and the BTA Instrument controller.

DRAWINGS

LOG SHEETS